National Aeronautics and Space Administration

NASA's Mars Exploration Program

The Evolving Next Decade

Intn'l Planetary Probes Workshop #6
Atlanta, GA
23-27 June, 2008

Doug McCuistion
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23 June 2008

phoenix

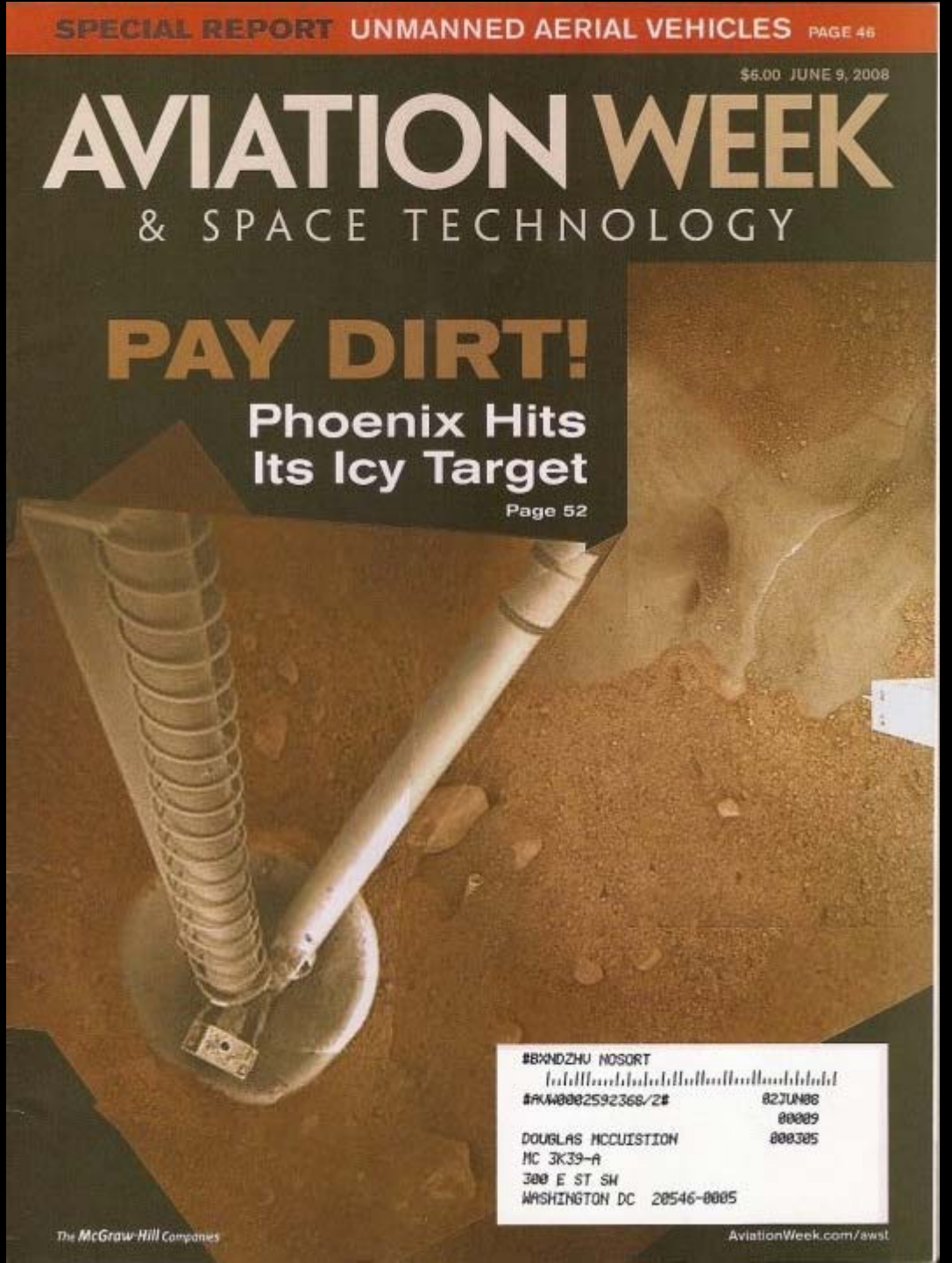
http://phoenix.lpl.arizona.edu

Mars Lander 2007

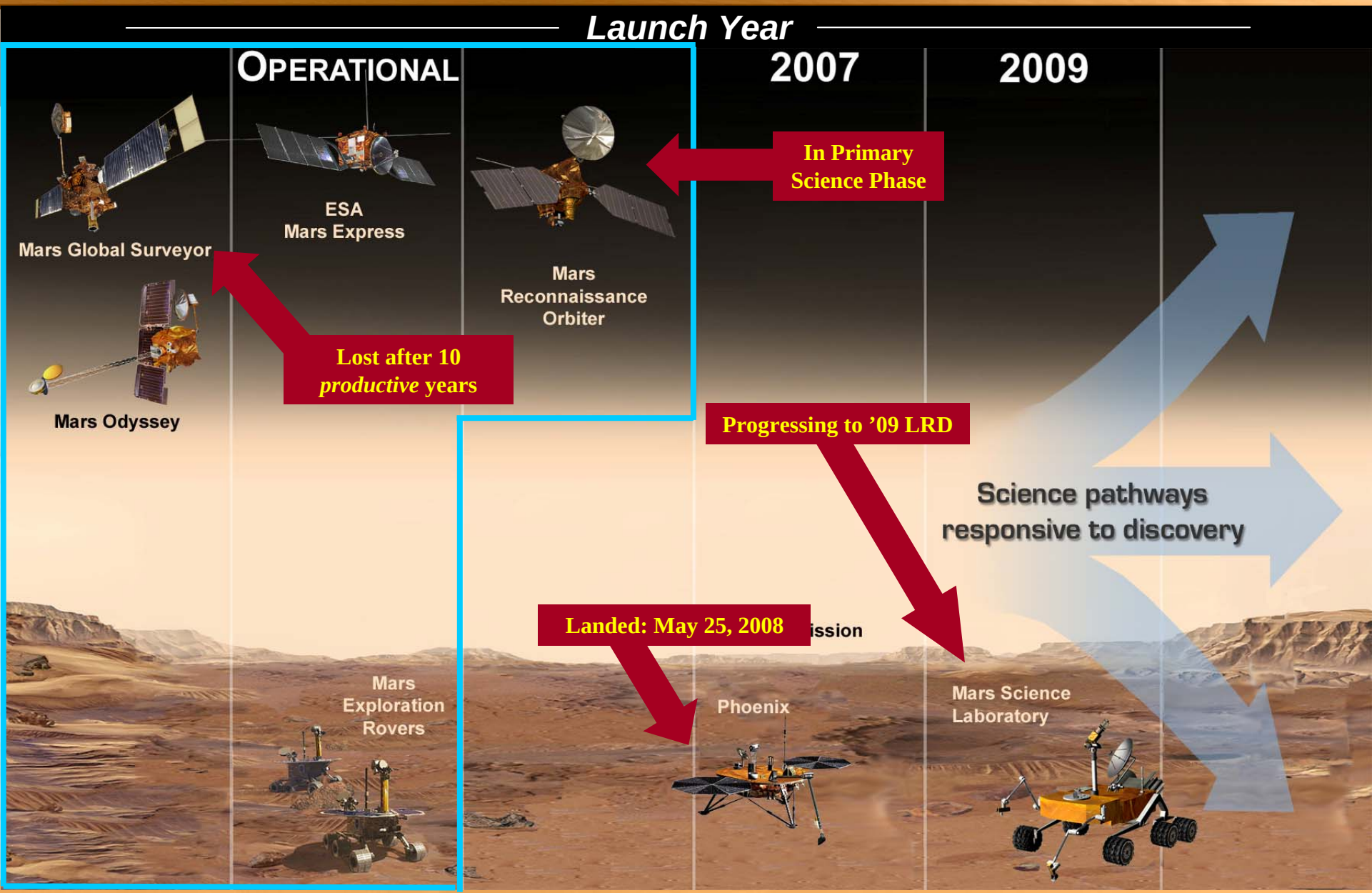
NASA

DEPARTMENT OF PLANETARY SCIENCES
LUNAR AND PLANETARY LABORATORY
UNIVERSITY OF ARIZONA TUCSON, AZ

On Mars
May 25th, 2008



Mars Exploration: An Outstanding Decade!



The Power of a Program:
HiRISE Captures Phoenix EDL

"Phoenix On the Chute!"

Restoring a Viable MEP Architecture

Launch Year

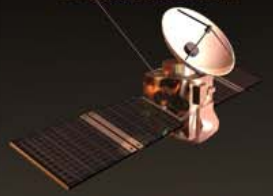
2009

Mars Science Laboratory

2011

2013

Competed Aeronomy Scout Mission



MAVEN or TGE

ESA ExoMars cooperation

2016

TBD mission based on budget and science feed-forward

2018

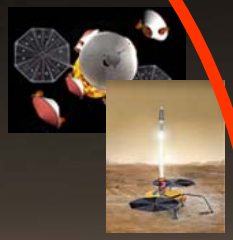
MSR Element #1

?

Sample Receiving Facility online by 2022

2020

MSR Element #2



Fundamental MEP Topics for the Next Decade

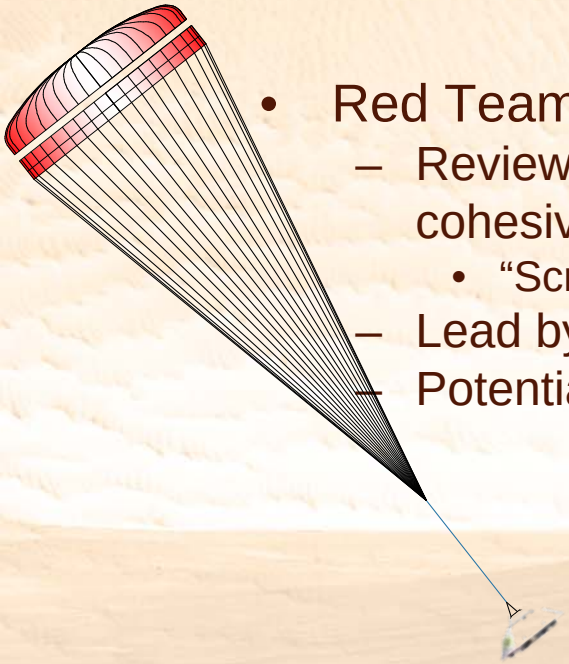
- What are the driving requirements behind the Program's baseline content?
  - Flying in every opportunity directed by 2008 Congressional Appropriations Bill—*it's the law!*
  - FY09 President's Budget required Mars Sample Return studies and reporting
  - Presidential election year creates air of uncertainty for FY10 budget process
- The FY09/10 budget must create a stable, executable program
  - Portfolio must reflect methodical scientific progress and stakeholder expectations
  - Maintain Program integrity
  - "Repairs" through the 2010 budget process
- Communications infrastructure in the Next Decade—how do we implement it?
- Maintenance of critical core competencies
  - Get to the surface frequently
  - SkyCrane needs to be the workhorse—MSL→MSR gap is unacceptable
- MSR in 2018 is *not viable*
  - $3.5B (US) price tag is probably not viable either
    - 1st Independent Cost Estimate tends to support this assumption

Fundamental MEP Topics for the Next Decade

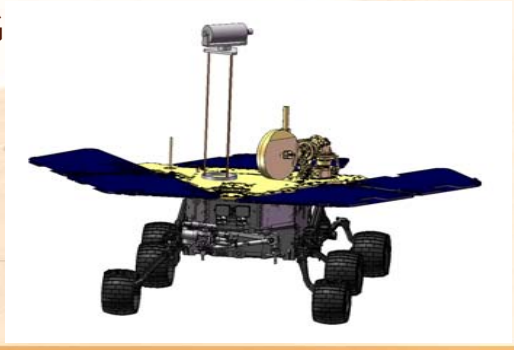
- How does Mars Sample Return fit in the architecture?
  - Momentum is high
    - Mars community understands need to skip opportunities to execute this mission
    - NRC's *Astrobiology Report on the Exploration of Mars* again endorsed MSR, and believes we know "enough" to make it meaningful
    - Several studies underway—NASA, ESA Bi-laterally, and IMEWG/iMARS
  - Cost is high, even as an International cooperative
    - NASA will develop/cost a NASA-only mission as a baseline
    - It <u>will</u> require skipping opportunities, even with significant international partnership
- NASA *dependency* on international cooperation should be limited to MSR
  - Participation in ExoMars (2013) and MarsNet (2016) are highly valuable
    - A la MEX, MRO, MSL, etc
  - Early cross-collaboration crucial to a successful attempt at MSR
- Technology development must enable all missions in the portfolio
  - Re-establish a stable technology budget (after MSL)
  - MSR technology development is the driver
    - Technology roadmap with early infusion that also enables the early missions
    - Technology wedge beginning after MSL
  - For MSR, parallel development for key technologies will reduce mission risk

Creating a Viable Next Decade w/Community Support

- Mars Architecture Tiger Team (MATT)
  - Initially created to analyze program options after FY09 budget release
  - Reconstituted after Feb ’08 MEPAG meeting
  - Purpose: propose a Mars exploration architecture(s) that will optimize the science return within fiscal and programmatic constraints
    - Include program with deferred MSR options



- Red Team Review—Mars Architecture Review Team (MART)
  - Review fiscal, programmatic, and systems engineering cohesiveness of planning
    - “Scrub” needed after 3 tumultuous years of continual re-planning
  - Lead by Scott Hubbard
  - Potential report to MEP before MEPAG



Creating a Viable Next Decade w/Community Support (con't)

MATT-identified building blocks to address the key scientific objectives thru 2025:

- **Mars Sample Return Lander (MSR-L) and Orbiter (MSR-O)**
  - Two flight elements: Lander/Rover/Ascent Vehicle & Orbiter/Capture/Return Vehicle
  - High-priority in NRC reports and Decadal Survey; must address multiple science goals with samples meeting the minimum requirements set out in the ND-SAG report
- **Network (NET):**
  - 4 or more landed stations arrayed in a geophysical network to characterize interior structure, composition, and process, as well as surface environments
  - Meteorological measurements would be leveraged by contemporary remote sensing from orbit (e.g., MSO)
  - High-priority in NRC reports and Decadal Survey
- **Mars Science Orbiter (MSO)**
  - Atmospheric and surface climatology remote sensing plus telecom
- **Mars MER+ Rover**
  - MER+ rover deployed by "Sky Crane" to new water-related geologic targets
  - Precision landing (<6-km diameter error ellipse) enables access to new sites
  - Conducts independent science but with scientific and technical feed-forward to MSR
  - As a precursor, this opens the possibility for payload trade-offs with MSR Lander
- **Mars Scout Missions (Scout)**
  - Competed missions to pursue innovative thrusts to major missions goals

Architecture Smorgasbord

MATT-provided Options for MEP Consideration

Option	2016	2018	2020[#2]	2022[#2]	2024	2026	Comments
2018a[#1]	MSR-O	MSR-L	MSO	NET	Scout	MPR	Funded if major discovery?
2018b[#1]	MSO	MSR-L	MSR-O	NET	Scout	MPR	Restarts climate record early; trace gases
2018c[#1]	MER+	MSR-L	MSR-O	MSO	NET	Scout	Gap in climate record; telecom?
2020a	MER+	MSO	MSR-L	MSR-O	NET	Scout	MER+ helps optimize MSR
2020b	MER+	Scout	MSR-L	MSR-O	MSO	NET	Gap in climate record, early Scout
2022a	MER+	MSO	NET	MSR-L	MSR-O	Scout	Early NET; MER+ helps MSR
2022b	MSO	MER+	NET	MSR-L	MSR-O	Scout	Early NET, but 8 years between major landers (MSL to MER+)
2024a	MER+	MSO	NET	Scout	MSR-L	MSR-O	Early NET; 8 years between major landers; late sample return

Assumptions: 2011 skipped, and 2013 Scout on-track

MSO = Mars Science Orbiter

MER+ = Next Generation Mars Rover (Likely to be between MER- & MSL-class Rover with precision landing and sampling/caching capability)

MSR = Mars Sample Return Orbiter (MSR-O) and Lander/Rover/MAV (MSR-L)

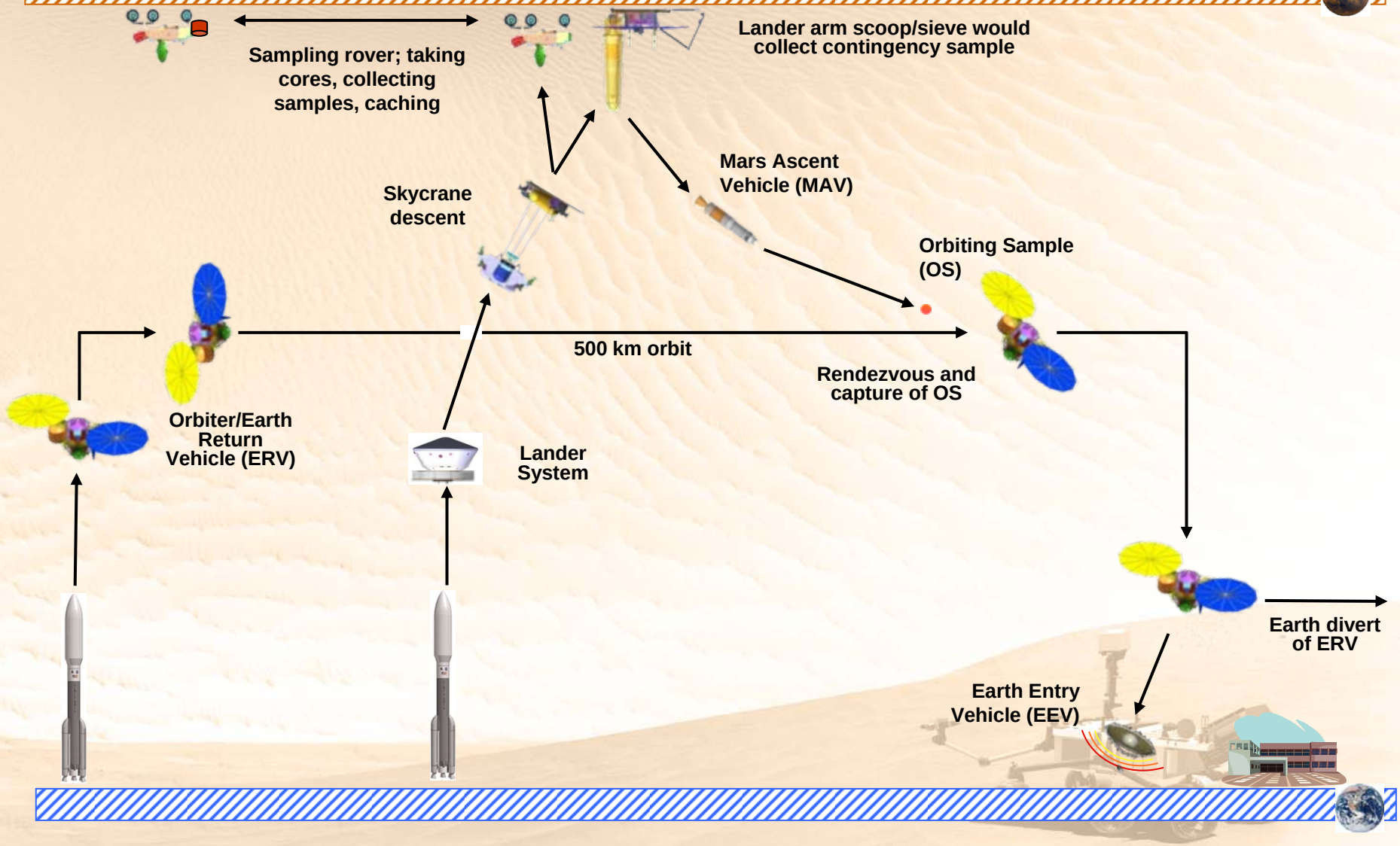
NET = Mars Network Landers ("Netlander") mission

FOOTNOTES:

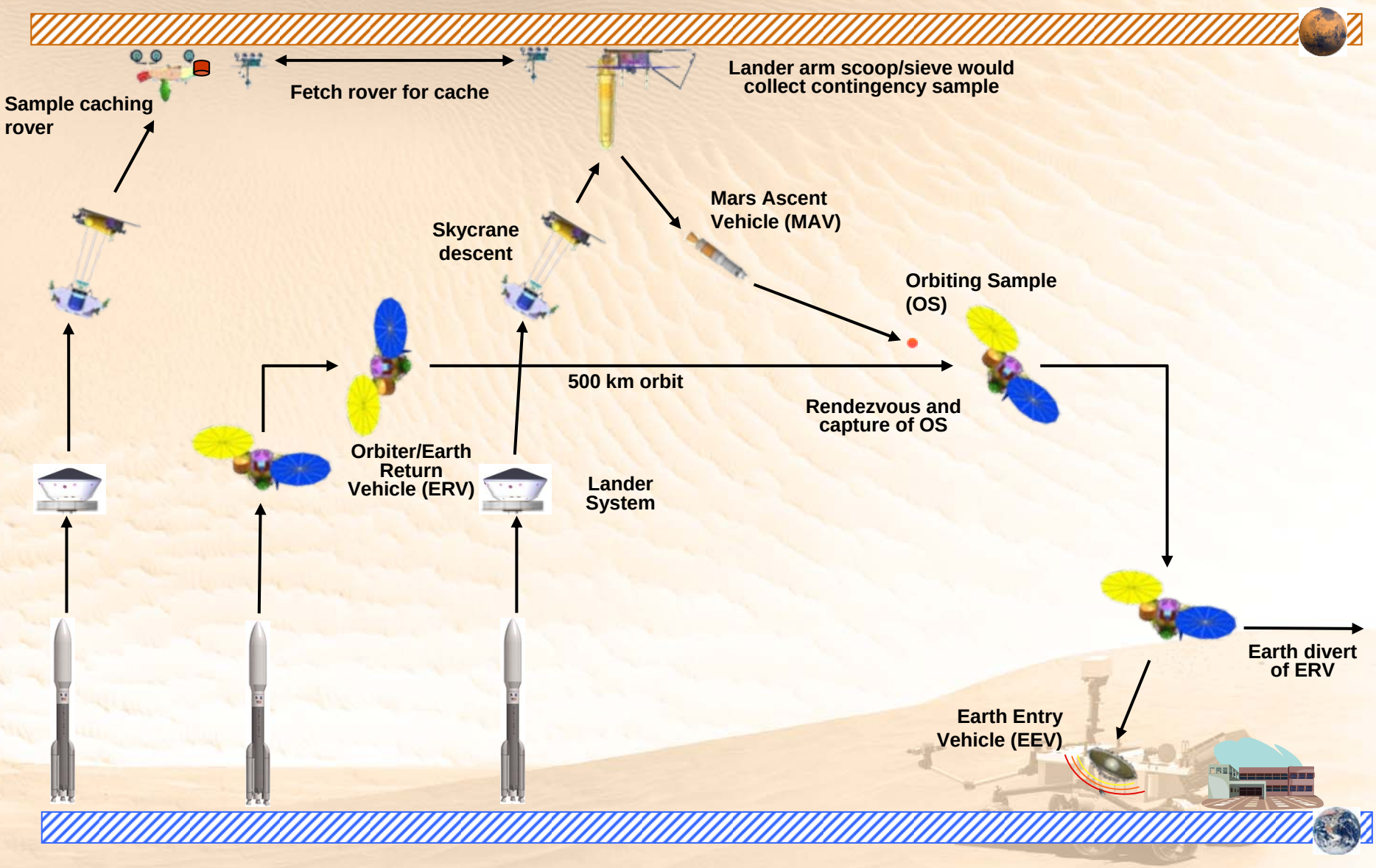
#1 Requires early peak funding well above the guidelines

#2 Celestial mechanics are most demanding in the 2020 and 2022 launch opportunities, but ATLAS V-551 capabilities presently appear to be adequate

Mars Sample Return
(2-launch Scenario)



Mars Sample Return
(3-launch Scenario)



MSR—NASA Planning

- MSR Planning Ground Rules
  - **Telecomm** relay must be available to support landed element(s)
  - **Landing site** at ±30 degrees latitude and >0 km MOLA
  - **NEPA** process would need to begin more than 10 years before samples leave Mars
  - **Mobility** required to collect diverse samples either within or just outside landing ellipse
    - Time to collect samples vs time on surface is key trade
    - MAV and rover lifetimes are factors
  - **SRF** and ground facilities is included in planning for all architecture options

- Programmatic
  - Budget expectations must be credible and defendable
    - Cost estimates will drive launch date possibilities
  - Core Competencies must be maintained to support future viability
  - Long-lead technology development required
  - International collaboration is probably necessary

MSR—Community Input

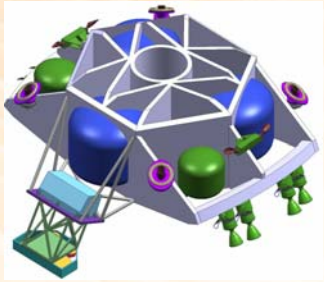
- MEPAG Next Decade Science Assessment Group (ND-SAG; Feb. ‘08)
  - Analyze critical Mars science in conjunction with, and complementary to, MSR
  - Evaluate science priorities guiding the makeup of the MSR sample collection
  - Determine dependencies of mobility and surface lifetime on science objectives, sample acquisition capability, diagnostic instrument complement, and number and type of samples
- Mars Architecture Tiger Team (MATT; Feb & May ‘08)
  - Chartered to examine next-decade architecture(s) that fit the current Program budget and phasing
- PSS (Mar ’08)
  - Endorsed MSR and setting budgets to support it
- CAPTEM (Apr ‘08)
  - Conference on scientific purpose(s) of MSR
- PPS (May ‘08)
  - Draft recommendations endorse MEP/PPO efforts to update Draft Test Protocol and plan for SRF

MSR—International Planning

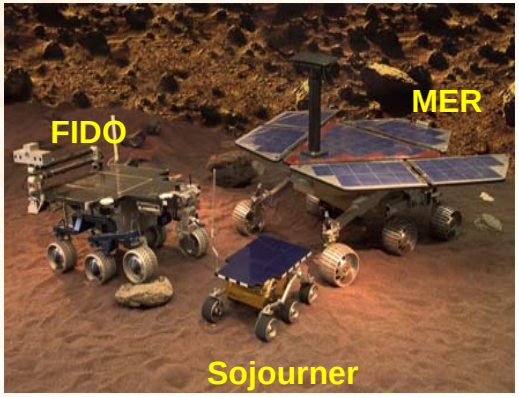
- International Mars Architecture for the Return of Samples (iMARS; Sept ’07, Nov ‘07, Mar ‘08)
  - Chartered by IMEWG to define an affordable international MSR architecture
  - Three subgroups: Science, Engineering, and SRF/Curation
  - Phase I report to IMEWG in July
    - Phase II charter to be presented
- Bilateral studies with ESA (Oct. ‘07, Jan ‘08, May ‘08)
  - Mission design, mass estimation, biocontainment
  - Support iMARS engineering team
- ESA/CNES International MSR Conference in July
  - Focus on ESA’s Aurora Programme
  - Rollout of iMARS architecture

Conclusions

- Re-establishment of a viable Program underway
  - MSL is significant challenge in 2008/09
  - Fly every opportunity
    - Budget restoration in 2010+ to TBD levels
  - Invest in MSR technology early
    - Enabling technologies can enhance earlier missions, e.g. 2016 lander
    - Control “appetites” to create an affordable mission



- Definition of 2016 mission is pending
  - MATT recommends getting to the surface
    - Supports Program goals of core competencies
    - Could be proving ground for MSR-related technologies
  - SAG then SDT for mission definition
  - Build-to-print hardware important
    - Fly what’s proven—standardize infrastructure
    - Keep costs down
    - Simplify developments



- Continue international MSR development through iMARS and with ESA
- Coordinate enabling infrastructure through IMEWG, especially communications
- Final architectural decisions heavily influenced by work of MATT
  - Architectural decisions will be vetted through advisory structures
    - MART, NRC and NAC PSS